Title: Update on the Status of Modernizing NC3

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Update on the Status of Modernizing NC3

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Nuclear Command Control and Communication (NC3): What it is

"a large and complex system comprised of numerous land-, air-, and space-based components used to assure connectivity between the President and nuclear forces. The current NC3 architecture consists of components that support day-to-day nuclear and conventional operations prior to a nuclear event as well as those that provide survivable, secure, and enduring communications through all threat environments. Though some NC3 systems are specific to the nuclear mission, most support both nuclear and conventional missions. The Department of Defense (DOD) is executing several acquisition efforts to modernize elements of NC3."

GAO-15-584R NC3 Modernization Review June 15, 2015

Not made up of single mission elements

Nuclear Command Control and Communication (NC3): What it does

During peacetime and crisis, the NC3 system performs five crucial functions:

1. Detection, warning, and attack characterization
2. Adaptive nuclear planning
3. Decision-making conferencing
4. Receiving Presidential orders
5. Enabling the management and direction of forces

Nuclear Posture Review, NPR 2018

Major element of overall deterrence strategy

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EST. 1943

Nuclear Command Control and Communication (NC3): Why it's needed

October 28, 1962: ~ 12.30 am Air Force Capt. William Bassett unit in Okinawa received authenticated launch order to fire Mace missiles *at China* and Russia in spite of Defcon2 not 1 status. He challenged the order, even after it was resent, and took measures to ensure no missiles would be fired, until stand-down order received.

October 27, 1962, ~ 5pm Vasili Arkhipov, political officer on Russian sub B-59 and in command of Russian sub flotilla, voted against firing nuclear torpedo at US aircraft carrier, 1 of 3 votes, after an argument.

September 26, 1983: Stanislav Petrov, lieutenant colonel in the Soviet Air Defense Forces, was the officer on duty at the Serpukhov-15 bunker near Moscow which housed the command center of the Soviet early warning system. Dismissed multiple warnings of incoming US missile attack as errors. Later alarm determined due to rare alignment of sunlight on high-altitude clouds and satellite orbits.

From: Peter Hayes, "NC3 Is There a Ghost in the Machine", April 9, 2018

Real people making important choices

Motivating Factors:

"Nuclear Weapons are less useful than boat anchors if the right people can not communicate with them."

"NC3 is a tool that will prevent conflict"

NC3 covers both ends of the political spectrum

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Current NC3 Status:

"The United States will sustain and replace its nuclear capabilities, modernize NC3 and strengthen the integration of nuclear and non-nuclear military planning."

"The United States must have an NC3 system that provides control of U.S. nuclear forces at all times, even under the enormous stress of a nuclear attack."

"Today's NC3 system is a legacy of the Cold War, last comprehensively updated almost three decades ago."

NPR 2018

"NC3" found 7 times in 2010, 45 in 2018 NPR

Current NC3 Statements:

Congressional Budget Office has estimated that modernizing the NC3 system will cost $58 billion over 10 years.

U.S. Strategic Command Gen. John Hyten:

"This is an old system, but by virtue of being old and of being a "closed network" it's also less vulnerable to cyber attacks then modern digital systems that are connected to the internet. It's very resilient against threats, and I'm very confident it can handle anything today."
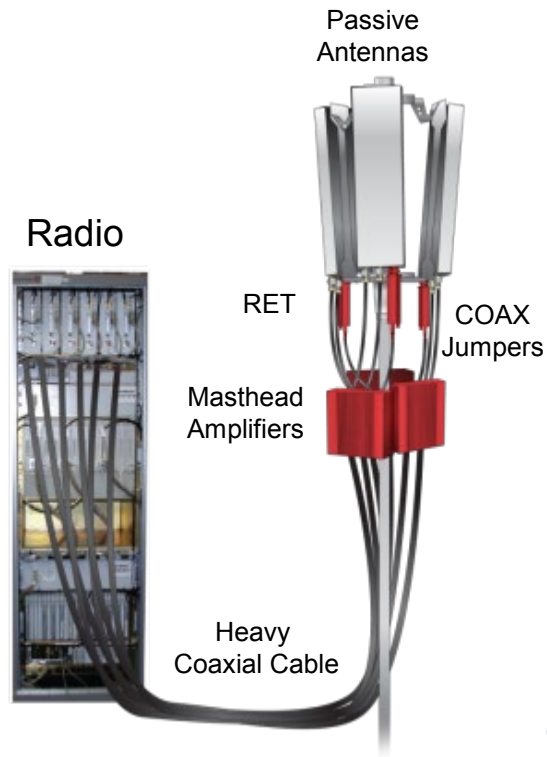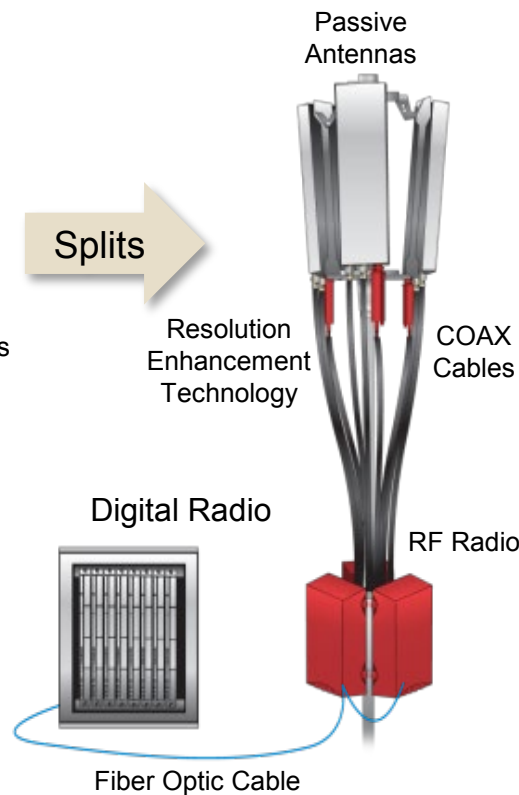
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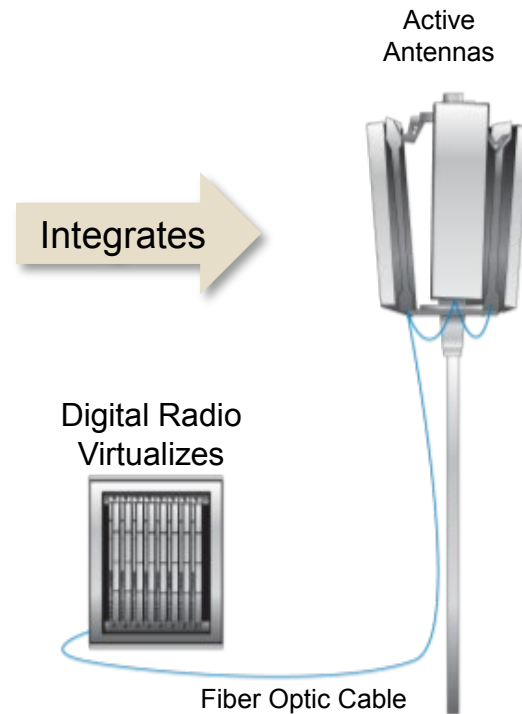# Show Peacetime NC3 System

Backhaul Communications Example

The Past

Radio

Passive Antennas

RET

COAX Jumpers

Masthead Amplifiers

Heavy Coaxial Cable

Splits

The Present

Passive Antennas

Resolution Enhancement Technology

COAX Cables

Digital Radio

RF Radio

Fiber Optic Cable

Integrates

5G

Active Antennas

Digital Radio Virtualizes

Fiber Optic Cable

From: Kevin Linehan VP ComScope

Communication systems change dramatically

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Who Misses Ma Bell?

The Bell Telephone Company "Ma Bell" controlled communications in the US and Canada from 1877 until 1984. NC3 was setup in the 1970's to 1980's timeframe.

Now, no one company in the U.S. is allowed end to end control of communications.

Huawei has established control of telephones, hardware, antennas, radio, front-haul and back-haul systems in China.

Monopolies create a big economic advantage

Huawei's Growth

The Rise of Huawei
Huawei's global smartphone market share (based on unit sales to end users)

- 2010: 1.5%
- 2011: 2.3%
- 2012: 4.0%
- 2013: 4.8%
- 2014: 5.5%
- 2015: 7.3%
- 2016: 8.9%
- 2017: 9.8%
- 2018: 13.0%

@StatistaCharts Source: Gartner

Huawei Tops Apple in Shrinking Smartphone Market
Top 5 smartphone vendors based on worldwide unit sales to end users

Q1 2018 / Q1 2019

- SAMSUNG: 78.6m / 71.6m
- HUAWEI: 40.4m / 58.4m
- Apple: 54.1m / 44.6m
- oppo: 28.2m / 29.6m
- vivo: 23.2m / 27.4m

Total smartphone sales
Q1 2018: 383.5m
Q1 2019: 373.0m

@StatistaCharts Source: Gartner

Who Is Leading The Race To Develop 5G?
Number of 5G standard technical contributions by company worldwide

Company	Contributions
Huawei Technologies	11,423
Ericsson	10,351
Hisilicon	7,248
Nokia	6,878
QUALCOMM	4,493
Samsung Electronic	4,083
ZTE (CN)	3,738
Intel (US)	3,502
LG Electronics (KR)	2,909
CATT (CN)	2,316
NTT DOCOMO (JP)	2,135
MediaTek (TW)	1,482
NEC (JP)	1,346

As of December 2018
@StatistaCharts Source: IPlytics

statista

70% more 5G contributions than Qualcomm and Intel combined

Unclassified

LANL's Unique Positon

Defense Information Systems Agency- Nuclear C3 System Description (NC3SD) Vol I to IV, **2003**

USSTRATCOM Project ---- Report, **2010**

Defense Information Systems Agency- Nuclear C3 System Description (NC3SD) Vol I to IV, **2018**

Mitch Seime – Lead Engineer

Intergovernmental Personnel Act (IPA)

Intergovernmental Personnel Act (IPA)

Chris Dowd – Lead Engineer

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First Step – Systems Analysis

LANL has over 20 years of Complex Network Analysis for Reliability Optimization

Call volumes at wire centers. Modeled to help establish architecture for US telecommunications

Infrastructure modeling tools have been developed to help inform decision makers

Path for Informed Modernization

Defense Information Systems Agency- Nuclear C3 System Description (NC3SD) Vol I to IV, **2003**

USSTRATCOM Project ----Report, **2010**

Defense Information Systems Agency- Nuclear C3 System Description (NC3SD) Vol I to IV, **2018**

Infrastructure Tools →

Inform Decision Makers

NC3 Modernization

Informed Modernization Implementation

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Security & Data Integrity

- Today's methods for cryptographic key distribution suffer from:
  - Unreliable security assurances
  - Unacceptable quality-of-service for critical infrastructure, handheld devices, emerging applications
  - Inadequate randomness for keys
- Network-centric Quantum-enabled security provides:
  - Network-compatible architecture
  - Future-proof security rooted in laws of physics
  - Highly leveraged integrated photonics technology
  - Cryptography is computationally lightweight
  - Scalable, affordable, deployable
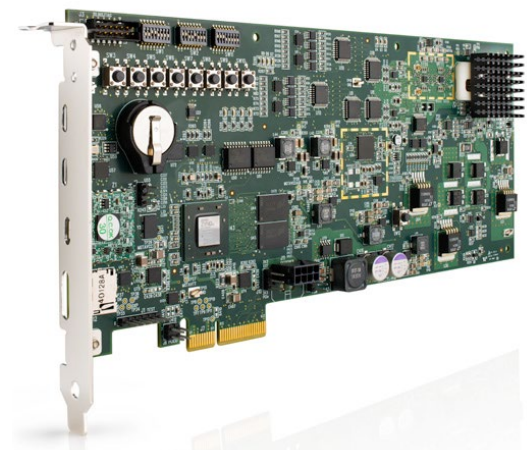
Entropy Engine
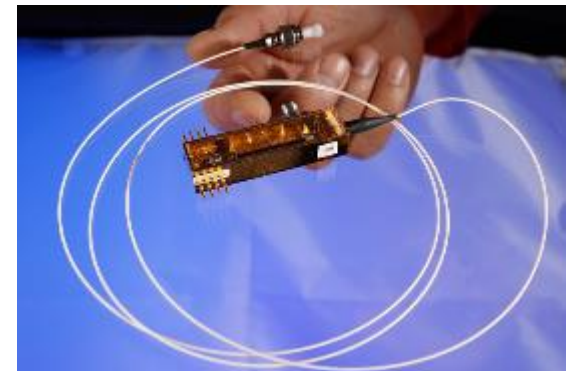
QKarD

"Strengthening protection against cyber threats" NPR 2018

Unclassified   **POC:** Ray Newell

Systems Integration

- Adhoc, self-forming, self-healing mesh network of 60-125 nodes for >1 year
- Area of 39 square miles
- Nodes communicate at 3 kbps @ 414 MHz at 19 km range
- Demonstrated data uplink to Iridium
- Ultra low power, radio is 1 Watt
- Temperatures, -40 – 185 degrees C
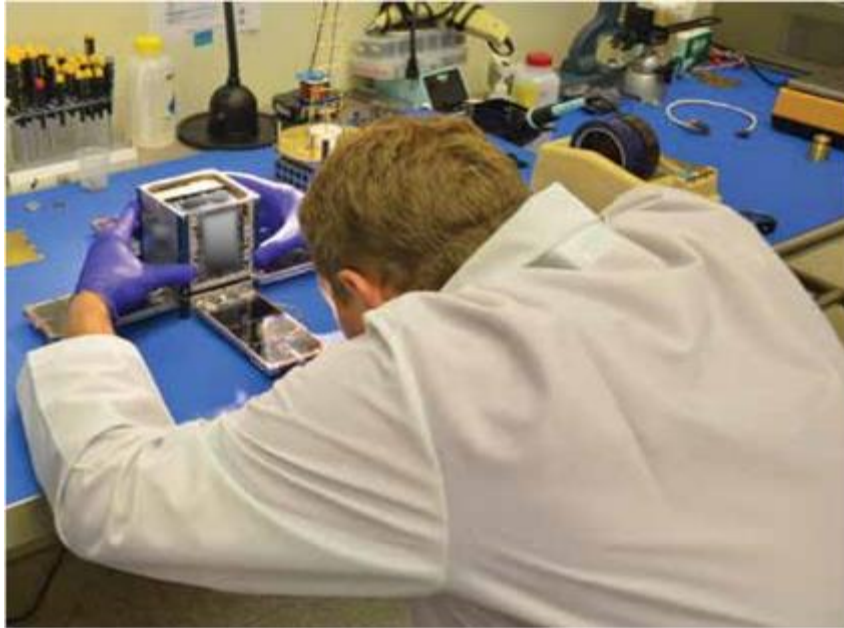- Cost $508 per node
- Graphic User Interface in near-real time
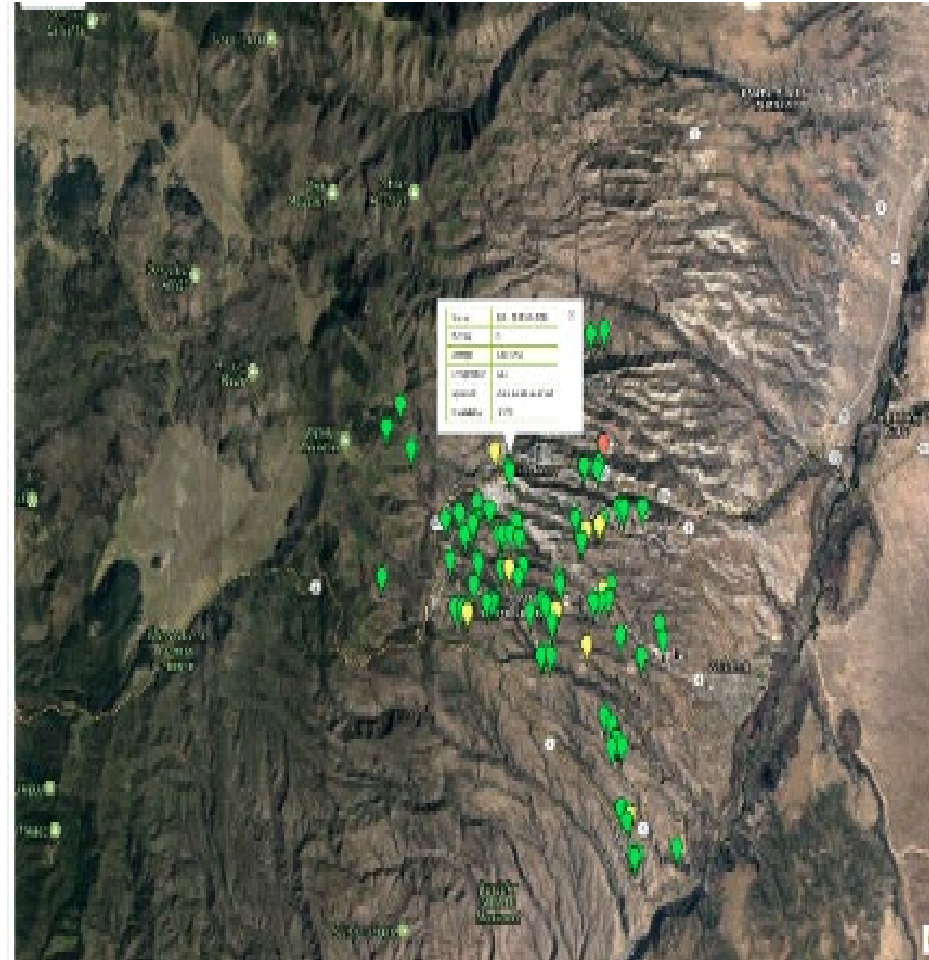
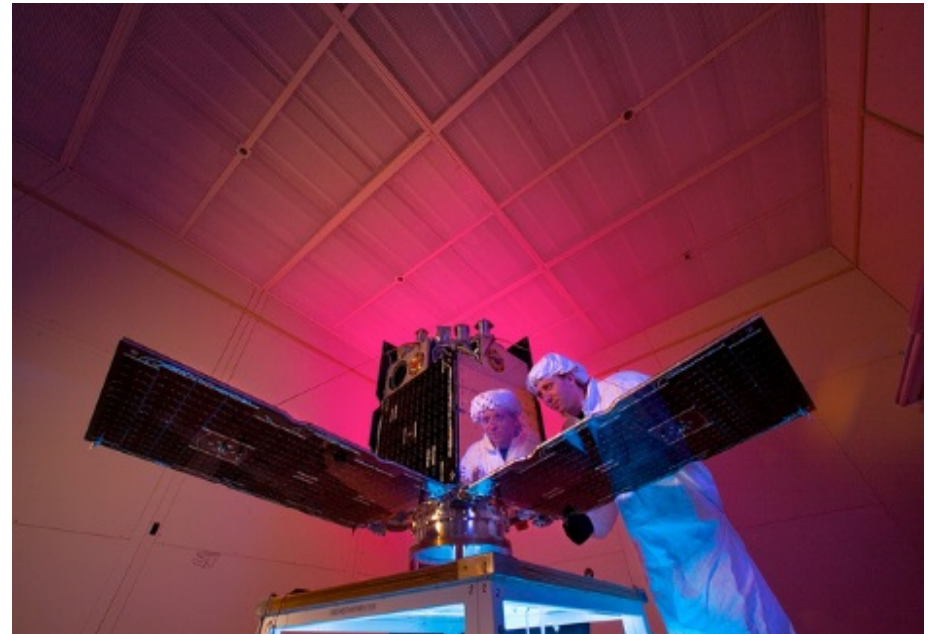"Enhancing integrated tactical warning and attack assessment " NPR 2018

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Smaller Space Systems

Perseus: December 8, 2010

Cibola: March 7, 2007

Compact Payloads
Increased flexibility
Multi-redundancies
Expendable

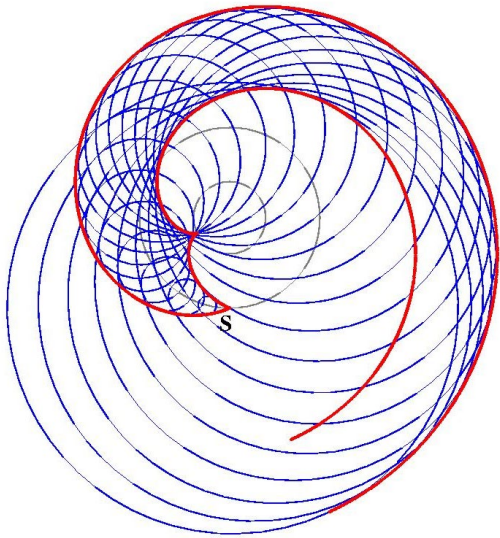"Strengthening protection against space-based threats" NPR 2018
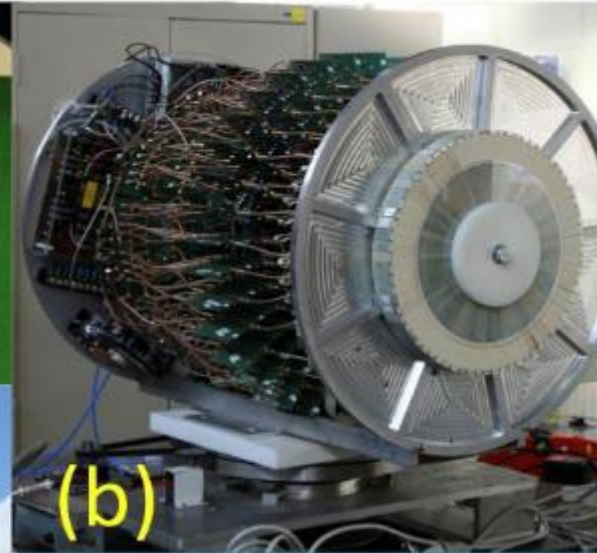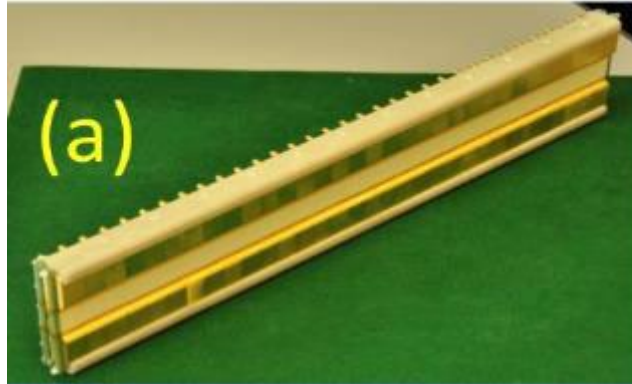
Unclassified   **POC:** Markus Hehlen

Novel Waveforms

Rotating polarization source

$$\nabla \times \mathbf{H} = \mathbf{J}_{free} + \epsilon_0 \frac{\partial \mathbf{E}}{\partial t} + \frac{\partial \mathbf{P}}{\partial t}$$
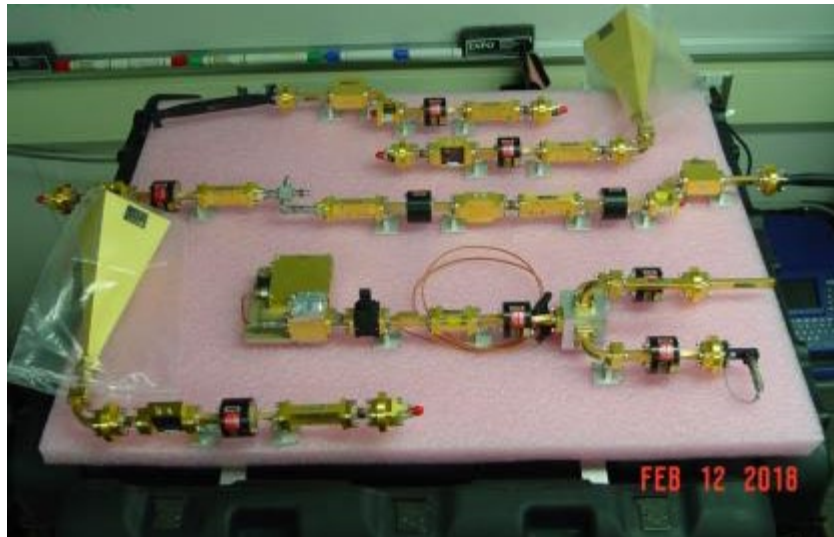
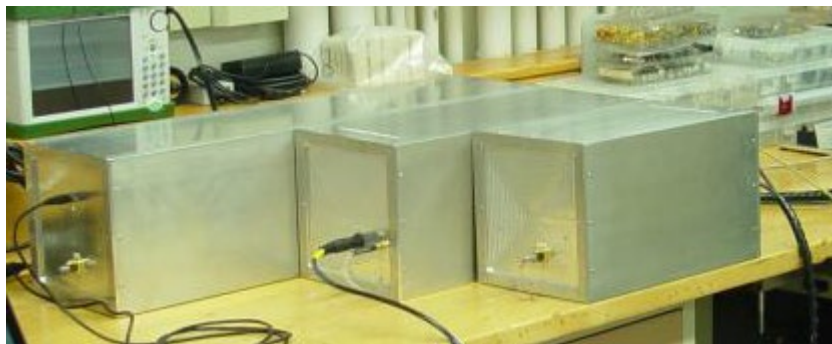"Improving command post and communication links" NPR 2018

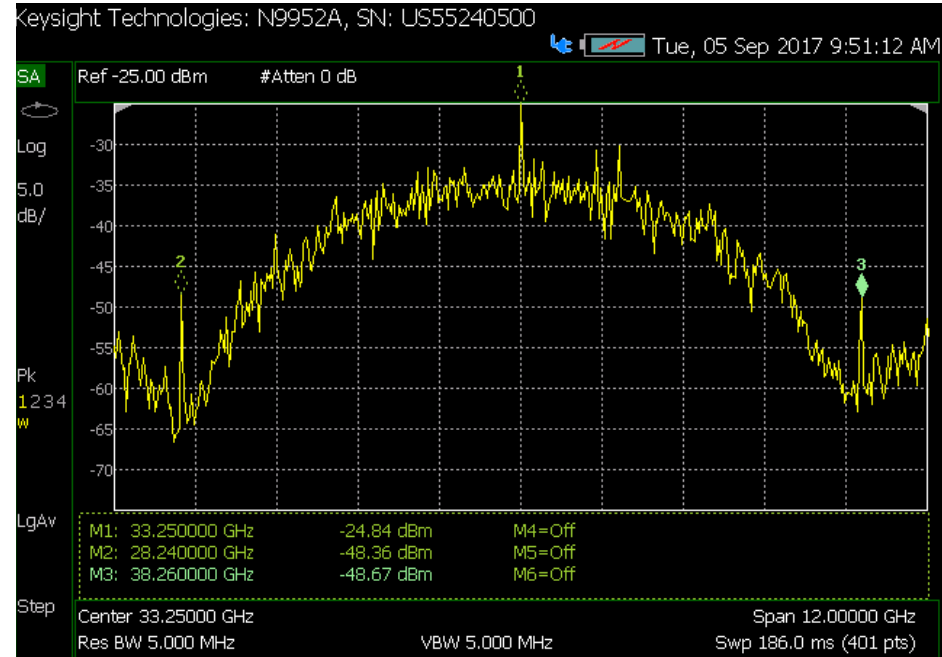# Code Division Multiple Access demonstrates 10-GHz of spread spectrum modulation at Ka-band

Hardware used for Ka-band demonstration

Spread spectrum signal from 28.25 GHz to 38.25 GHz (10-GHz bandwidth)

Transmitter box, receiver box, and box for common RF components packaged and sealed for outdoor testing

"Improving command post and communication links" NPR 2018

Unclassified   **POC:** Bruce Carlsten

Concerns for Future Communications

- How does a communication system stay up to date with rapidly changing technologies?

- Can a future system be robust, reconfigurable, resilient against cyber attack, space weather, EMP?

- What new technologies will be used?

- What new technologies will attack the system?

- How many redundancies are needed for air, space, land, and sea?

- Is system affordable?

What Role Can LANL Play:

- Subject matter experts for technology assessment
- Support development of technology integration roadmap
- Provide insights to the "Art of the Possible"
- Reduce "Technology Surprise"
- "Black Hat" system testing

LANL is here to support National Security needs

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